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OBSERVATIONS ON THE BACTERIOLOGY OF INFLUENZA AND BRONCHOPNEUMONIA *

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This report is based on a study of cases admitted to St. Luke's hospital with a diagnosis of influenza or pneumonia between Oct. 1, 1918, and Jan. 15, 1919. The patients did not belong to any one group, but came from all parts of the city. Some were travellers who became sick enroute and were taken off the train at Chicago. Except for 14 soldiers, the patients were civilians.

Bacteriology of the Sputum

Specimens of sputum were obtained by asking the patients to cough and spit into a sterile bottle which was immediately taken to the laboratory. The sputum, when tenacious enough, was washed by gently shaking in three changes of sterile broth or salt solution. A direct smear of part of the washed sputum was stained by Gram's method, and part was plated on fresh human blood agar and incubated at 37 C. Anaerobic human blood agar plates, semicoagulated horse serum shake cultures, and cultures in broth with varying amounts of whole human blood, serum, or washed red cells were made in 20 cases. While a greater variety of organisms could be cultivated by these methods, it was found that the bacteria which predominated in direct smears of good specimens of sputum grew aerobically on human blood-agar plates.

Considerable difficulty was encountered in collecting sputum. Not every patient could cough up material even on persistent effort. Frequently specimens consisted of thin, clear, somewhat frothy mucus. Such sputum showed a variety of organisms, large squamous epithelial cells and few or no leukocytes. There was a tendency for the bacteria to group about the squamous epithelial cells, and large numbers of streptococci were often attached to them. These streptococci were usually green forming, but sometimes hemolytic. The other organisms often found in this type of sputum were spirilla, fusiform bacilli, staphylococci, micrococcus catarrhalis, gram-positive diphtheroid bacilli, and very minute gram-negative anaerobic cocci and bacilli. As this kind of sputum may not originate at the site of the primary infection, but comes largely from the mouth and throat, not much importance attaches to the results of cultures made with it.

Specimens of coughed-up sputum, which were tenacious, showed the least variety of organisms, and it was only from this type of sputum that anything like pure cultures was obtained. The specimens were produced after an attack of coughing, which cost the patient considerable effort. The cough, though initiated voluntarily, if it was to be productive, passed out of the patient's

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control, became spasmodic, sometimes ending in wretching, and finally resulted in a clump of thick, very tenacious, clear or mucopurulent sputum.

Later in the disease when the patient was convalescent from pneumonia, the sputum was more abundant and less tenacious. A few cases had a persistent, productive cough until the time of discharge. This was ascribed to a persistent bronchitis.

Shortly before death, a thin, bloody fluid might run from the mouth. In one case the material coughed up about 4 hours before death was unclotted blood with a small admixture of mucus.

Blood in the sputum occasionally came from the nose, but otherwise bloody sputum was always associated with, and sometimes the first evidence of, pneumonia.

From patients with unproductive cough mucoid or mucopurulent material was frequently obtained from the nasopharynx, and examined by the same methods used for sputum.

Direct smears and cultures from 150 cases have been studied. The direct smear of a good specimen of sputum may give a better idea of the bacteriology of the disease than that afforded by culture alone. The smear indicates which organisms predominate, but of course cultures are essential to the complete identification of the organisms seen in the smear, and we made special and repeated efforts to get good specimens of sputum, and from most of the patients several samples were examined. The results are shown in table 1.

TABLE 1

RESULTS OF BACTERIOLOGIC EXAMINATION OF SPUTUM IN 150 CASES OF INFLUENZA

	Cases	Per Cent.
Only saliva obtained	12	8.0
Various organisms, none predominating	35	23.3
Thin, mucoid or mucopurulent material from the nasopharynx.		
Three organisms predominating and in about equal numbers	7	4.7
Strept. viridans, B. influenzae, and M. catarrhalis in 3;		
Strept. viridans, B. influenzae, and hemolytic strept. in 3;		
Strept. viridans, B. influenzae, and fusiform bacilli in 1.		
Two organisms predominating or the only ones present	44	29.6
Pneumococcus and B. influenzae in 22,		
The pneumococcus predominating in 13,		
B. influenzae predominating in 9,		
Strept. viridans and B. influenzae in 21,		
B. influenzae predominating in 13,		
Strept. viridans predominating in 8,		
B. influenzae and B. mucosus in 1 case.		
B. influenzae predominating, with a variety of other organisms	14	9.3
Pneumococci present in 3 of the 14 cases.		
Hemolytic streptococci predominating	4	2.7
Pure culture of one organism except for a rare colony of M. catarrhalis or staphylococcus	34	22.7
Pneumococcus	14 cases	
B. influenzae	12 cases	
M. catarrhalis	3 cases	
Hemolytic streptococci	3 cases	
Staphylococci	2 cases	

Influenza bacilli were found in 87 (63.2%) of 138 cases in which specimens of sputum or nasopharyngeal secretion were obtained. In the direct smear of the sputum, the influenza bacilli were of varied morphology, appearing in most cases as minute, gram-negative bacilli with rounded ends; usually short; sometimes in pairs like a pneumococcus, but much smaller. In some smears they were so small as to be overlooked easily. In other specimens they appeared as short threads. In sputum which gave a pure culture, they were astonishingly numerous, some being within the leukocytes.

In a bright, reflected light, the colonies on human blood-agar plates were visible as minute, transparent, convex points. By transmitted light, they were invisible. The blood was not changed. Unless the bacilli were numerous in the direct smear, it was very difficult to isolate them. Even when a good growth was obtained on the original plates, the bacilli might not grow in subcultures. Sometimes on the first plate cultures, the influenza bacillus forms long, slender threads like leptothrix, and quite unlike the short, coccoid form. The colonies of this form are slightly larger than those of the short form. It was noted that when the thread form appeared in the direct smears of the sputum, the colonies on the plates contained still longer threads. The same strain may give the two forms in different transfers.

None of the strains grew on hemoglobin-free mediums. In one sputum an organism was found which resembled the influenza bacillus in smears, but in cultures formed larger, opaque colonies and grew on plain agar.

There were frequently found on the plates many colonies of a small streptococcus which did not change blood. From an examination of the plates alone, it would be easy to confuse these colonies with those of influenza bacilli. They were sometimes numerous and occurred early in the epidemic.

When mixed with B. mucosus, the influenza bacillus may be overgrown unless transferred early.

Not much difficulty was found in growing the influenza bacillus in pure culture. Other organisms, such as staphylococci, were not necessary to its growth. In fact, the best plates came from sputum in which other bacteria were rare.

Pneumococci of all four types were found in 35 (25.4%) of 138 cases in which sputum or nasopharyngeal secretion was obtained.

PLEURAL EXUDATES

The pus from 8 cases of empyema was examined. In 3 cases hemolytic streptococci, in 4 pneumococci, and in 1 pneumococci and the influenza bacillus were obtained. The blood-tinged, straw colored fluid from another patient contained only influenza bacilli; this exudate was absorbed without drainage.

BLOOD CULTURES

Ninety blood cultures were made in 80 cases. Twenty were taken on the 1st day of the disease; 17 on the 2nd day; 8 on the 3rd day; 7 on the 4th day; 5 on the 5th day; 2 on the 6th day; 3 on the 7th day; 1 on the 9th day, and 1 on the 11th day. The rest were taken on the day of highest temperatures. Aerobic and anaerobic plates and cultures in broth were made in each case and daily transfers were made from the broth to human blood-agar slants.

Seventy-eight of the 90 blood cultures were negative. Blood cultures from 3 soldiers within 24 hours before death gave hemolytic streptococci. Pneumococci were found in the blood in 6 fatal cases, four of them with lobar pneumonia. There were only two positive blood cultures in patients who survived, both of these giving influenza bacilli.

CASES

The mixture of bacteria in the sputum and the negative blood cultures in most cases made the interpretation of the bacteriologic findings difficult. The organism which produces infection does not necessarily predominate in the sputum at the time it is examined. Because mixed cultures are inconclusive, the 34 cases in which practically pure cultures were obtained are of special interest. Included in this group are the cases in which the first plate or two might show a rare colony of M. catarrhalis or staphylococcus, but in which the third plate showed many colonies of only one organism. There were cases with only influenza bacilli, pneumococci or hemolytic streptococci not being found; there were pure pneumococcus cases, without influenza bacilli or hemolytic streptococci; and there were cases with only hemolytic streptococci, there being no pneumococci or influenza bacilli. Details are given in regard to a few typical and instructive cases.

CASE 1.—A soldier was admitted October 3 with the diagnosis of influenza. Hemolytic streptococci predominated in the sputum during life, and a blood culture 24 hours before death gave a similar hemolytic streptococcus. Postmortem examination showed bronchopneumonia and empyema, and hemolytic streptococci and influenza bacilli were cultivated from both lungs and from the trachea. The heart blood gave hemolytic streptococci and B. mucosus, the latter most likely being a terminal invader as it did not grow in the blood culture shortly before death.

The nurse who had charge of the soldier was taken sick before he died, and remained on duty until his death when she went to bed with a temperature of 102.6 F. The physical findings were those of bronchitis; the temperature rose to 104.2 that evening, became fluctuating but, on the whole, lower during the next 4 days, being 100.7 on the morning of the 5th day. On the 6th day, it rose to 105; at this time the leukocytes were 5,400. The first specimen of sputum was obtained on this day; it was mucopurulent and tenacious, coming from the lower air passages, and smear showed inumerable small, gram-negative bacilli. The plates showed a pure culture of influenza bacilli, except for a rare colony of staphylococcus. There were no pneumococcus or streptococcus colonies. On the afternoon of this day the first signs of bronchopneumonia were found in the lower right lobe. The following day, the temperature again reached 105 F., the leukocyte count was 9,700, and the signs of bronchopneumonia in the right lower lobe were more marked. The sputum was mucopurulent and blood streaked. On the 10th day the temperature remained high, and a blood culture was made, but it remained sterile. On the 11th day, the temperature fell to 99, and the patient was much improved. The sputum was still mucopurulent, tenacious, and blood streaked; and it still gave pure culture of influenza bacillus except for a rare colony of staphylococci. On the 17th day the patient complained of a pain in the right side of the chest, the temperature rose to 101.8 and the leukocyte count to 20,000. Coughing was painful and no sputum was procured until the 19th day when a right-sided effusion had relieved the pleural pain. This sputum was greenish, mucopurulent and blood streaked, and instead of pure culture of influenza bacilli, it gave a mixture of influenza bacilli and pneumococci—type III—the pneumococci predominating. On the 21st day, faintly blood-tinged, slightly clouded, straw-colored pleural fluid was aspirated; smears showed some leukocytes and small, gram-negative bacilli, and cultures gave influenza bacilli, no pneumococci being found either in smear or culture. The fluid in the chest was absorbed without drainage.

On the 26th day, when the temperature was normal, the sputum was still mucopurulent with streaks of blood, and cultures gave numerous pneumococci, no influenza bacilli, and a few M. catarrhalis, and a streptococcus which did not change blood.

Case 2.—Patient admitted October 9, in premature labor, temperature of 104 F.; diagnosis, influenza. A living child was born. There were signs of consolidation of the right lung, more marked in the upper lobe, and of a less extensive bronchopneumonia on the left side. The leukocytic count was 6,400; the sputum mucopurulent and tenacious. The predominant organism was the influenza bacillus. There were many colonies of B. mucosus and a few of a hemolytic streptococcus. Death occurred on the 5th day after entrance. Blood culture on the last day of life gave pneumococci, type III. Examination 2 hours after death showed the oldest pulmonary lesion to be a confluent bronchopneumonia of about two-thirds of the right upper lobe. Most of this area was gray. Cultures of pneumonic tissue cut out of this lobe after searing the pleural surface gave inumerable colonies of influenza bacilli with only 3 colonies of staphylococci on 3 plates. No other organisms were found in this lobe.

The lower right and left lobes contained discrete dark red patches of fresh bronchopneumonia, cultures of which at the end of 24 hours showed numerous colonies of influenza bacilli, fewer pneumococcus colonies, and scattered colonies of staphylococci, which were overgrown at the end of 48 hours by B. mucosus. There was a bilateral thin, turbid, yellow pleural exudate, which contained pneumococci and B. mucosus. In the left tonsil was a chronic abscess, the pus containing B. mucosus and a hemolytic streptococcus.

Case 3.—A soldier was admitted October 23, the 5th of illness, with broncho-pneumonia in the lower right lobe, temperature of 103 F. By the 11th day all the lobes were involved in the process. The leukocyte count on admission was 4,200. For the next 4 days the patient was very sick and unable to cough up anything. On the 9th day the temperature was 104, and a specimen of mucopurulent sputum was obtained, which on cultures showed many colonies of influenza bacilli, some colonies of pneumococcus—type II—and a few colonies of M. catarrhalis. The influenza bacilli greatly predominated. This bacteriology of the sputum persisted except for an increase in the relative numbers of pneumococci until the 15th day; after that it was not examined.

Blood cultures on the 7th and 9th days were sterile; on the 11th day the blood gave a growth of pneumococcus, type II. On the 14th day the leukocytes were to 23,300. Although the patient seemed much improved on the 17th day, the blood cultures still contained pneumococci; an ulcerative mitral endocarditis developed, and on the 23rd day a pneumococcus meningitis was diagnosed. Death occurred 4 days later.

Postmortem examination showed bronchopneumonia in the lower and upper right lobes and in the left lower lobe. Cultures of the pneumonic areas yielded influenza bacilli and pneumococci, with occasional colonies of M. catarrhalis. Cultures of the vegetations on the heart valves gave only pneumococci.

CASE 4.—A young woman was admitted October 28, with bronchitis and a patch of bronchopneumonia in the lower right lobe, temperature 101.8. F. She said that she had felt badly for a week, but had not been in bed; leukocyte count 2,700; no spontaneous cough or expectoration; a forced cough resulted in a small amount of clear mucus which contained in order of frequency, hemolytic streptococci, influenza bacilli, and M. catarrhalis. Two days later the sputum gave the same result. Five days later, the temperature being normal, hemolytic streptococci predominated in the sputum, and no influenza bacilli were found. Blood culture on the day of admission was negative; on the following day, when the temperature had risen to 104, blood culture showed influenza bacilli. There were no complications, the temperature falling to normal 2 days later.

CASE 5.—A nurse became ill October 18, with lobar pneumonia on one side and of bronchopneumonia on the other side; leukocyte count was 26,300; sputum scant, sligtly yellow, tenacious, the cultures showing numerous colonies of influenza bacilli (leptothrix form), and many but less numerous colonies of pneumococcus—type III. Blood culture on the 1st day of the disease gave the leptothrix form of the influenza bacillus; no pneumococci. This patient recovered quickly and completely.

CASE 6.—A soldier became ill on a train and entered the hospital October 26, with a temperature of 101 F.; leukocyte count, 4,800; slight cough but very little sputum; highest temperature was 101.8. He did not develop pneumonia and recovered promptly. A small amount of clear, tenacious sputum containing some coal pigment was obtained the day of admission, smears of which showed some leukocytes and many small gram-negative bacilli. The cultures yielded innumerable colonies of influenza bacilli and a few colonies of staphylococci. There were no colonies of pneumococci or streptococci. Two days later the temperature being normal, a small amount of clear mucus expelled by forced cough still contained innumerable influenza bacilli, and also some streptococci of both viridans hemolytic types.

CASE 7.—A woman was admitted October 10, with diagnosis of influenza and bronchopneumonia; temperature, 104.2 F.; leukocyte count, 6,600. For 2 days the patient was quite sick; then she began to improve and at the end of 12 days the temperature was below 100. It went as low as 98.2, but frequently rose to 99 and a fraction until the time of discharge 10 days later. This incomplete recovery was associated with bronchitis. There was frequent cough, and abundant mucopurulent sputum. During all this time the sputum was practically a pure culture of influenza bacilli except for an occasional colony of staphylococci and a few hemolytic streptococci in the last specimen examined before the patient went home.

Case 8.—A nurse had a light attack of illness during October when the epidemic was at its height, but was not particularly sick and worked while she had a persistent dry cough and a pain in the right chest. On November 6, she went to bed though her symptoms were not much worse than they had been for some time. Temperature, 101.6 F.; leukocyte count, 14,400; a slight friction rub over the lower right lobe; cough troublesome, and only after considerable effort was any sputum obtained, which seemed to come from far down in the chest. Cultures of the mucopurulent sputum yielded numerous colonies of influenza bacilli, many of Strep. viridans, a few of M. catarrhalis, and an occasional colony of hemolytic streptococci. Another specimen obtained after the temperature had been normal 15 days, gave the same result with the addition of a few staphylococci. The patient continued to cough with diminishing expectoration for 3 weeks after the temperature became normal. The throat and nose cultures were negative for influenza bacillus while the sputum was positive. At the time this nurse sought treatment for the persistent cough and pain in the side, there was a limited epidemic among the nurses, and the patient volunteered the information that all of the nurses who were sick at that time had been associated with her.

Case 9.—A man was brought into the hospital very sick, November 3. He had been ill at home a week. The lower left lobe was solid; he was delirious and died within 48 hours. Blood culture 20 hours before death contained pneumococcus—type III. The sputum on admission was mucopurulent and tenacious; it contained no influenza bacilli and no streptococci, the predominant organism being pneumococci—type III. There were some colonies of a small streptococcus which did not change blood, and a few colonies of staphylococci. On postmortem examination there was found an extensive confluent bronchopneumonia in all the lobes, most marked in the lower, and the pneumonic areas gave no influenza bacilli, only the pneumococcus in practically pure culture.

Case 10.—A colored woman was admitted December 10; temperature of 100.8 F.; grunting expiration; left lower lobe solid; a leukocyte count of 20,400; the sputum mucopurulent, rusty and tenacious, gave a pure culture of pneumococcus—type I; a blood culture on admission gave the pneumococcus. The patient died 2 days later.

COMMENTS ON CASES

The first of the cases is of interest because the nurse presumably contracted the disease from the soldier in whom hemolytic streptococci predominated and in whom pneumococci were not found. Hemolytic streptococci which predominated in the sputum and were present in the blood culture of the soldier were found in neither sputum nor blood of the nurse; while pneumococci, which appeared in the nurse's sputum, was not found in the soldier. The only organism found in both was the influenza bacillus. The second point is that the influenza bacillus, practically pure in the sputum, preceded the appearance of the pneumococcus, and that once the pneumococcus appeared, it was not long before it had entirely supplanted the influenza bacillus. The rise in leukocytes from 5,400 to 20,000 might be attributed either to the invasion of the pneumococcus or to the involvement of the pleura by the influenza bacillus.

The second case had a complicated bacteriology including the influenza bacillus, the pneumococcus, and B. mucosus. The presence in pure culture of the influenza bacillus in the oldest bronchopneumonic area indicates that its invasion of the lung antedated that of B. mucosus and pneumococcus. It is probable that the hemolytic streptococcus and B. mucosus found in the sputum were present in the chronic tonsillar abscess before the onset of influenza.

In Case 3, the pneumococcus and the influenza bacillus were present in the sputum on the 5th day of the disease. There is nothing to indicate which, if either, was the primary invader. The pneumococcus did not appear in the blood until the 11th day of the disease.

Case 4 was a typical, fairly mild case of influenza with leukopenia and a small patch of bronchopneumonia. This patient is one of the two who had positive blood cultures and recovered. It is of interest because the influenza bacillus was found in the blood culture when it was not the predominant organism in the sputum.

Case 5 is noteworthy because the bacteriology of the sputum and the physical findings indicated a combination of bronchopneumonia and lobar pneumonia; it is the other of the two cases in which recovery occurred after influenza bacilli had been demonstrated in the blood.

Case 6 was a mild case of influenza without pneumonia, with leukopenia and many influenza bacilli, but no pneumococci or streptococci in the first specimen of sputum.

Case 7 was characterized by bronchitis with mucopurulent sputum following influenza. The patient was expelling large numbers of influenza bacilli at the time of her discharge, and might continue to do so for a long time.

Case 8 may be classed as a carrier of influenza bacilli since the sputum contained the bacilli at least 15 days after the temperature was normal.

Case 9 is one of fatal bronchopneumonia in which only pneumococcus—type III—was demonstrated. The short time required for this organism to overgrow the influenza bacillus in the sputum of Case 1 suggests that pneumococcus III may not be the primary invader, even in those cases in which it is found in practically pure culture.

Case 10 is an example of what has been diagnosed in this series as typical lobar pneumonia. The patient had grunting expiration, a lobar consolidation, a high leukocyte count, and pneumococci in pure culture in the sputum and blood. The two specimens of sputum in which staphylococci appeared in pure culture and the three which yielded a pure growth of catarrhalis were examined late in the disease. These organisms were not found in pure culture in the sputum early in the disease, and were not found in the blood cultures. They doubtless were secondary invaders.

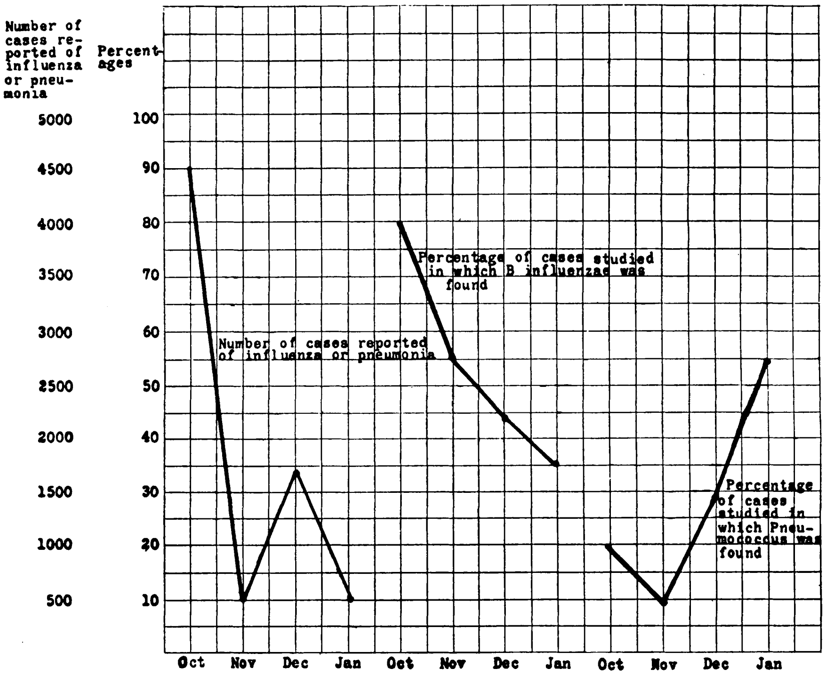

Chart 1.—Relation of results of bacteriologic studies to influenza and pneumonia in Chicago.

DISCUSSION

Green-forming streptococci and streptococci which did not change blood were found frequently in the sputum, but never in pure culture, and were not isolated from the blood or from pneumonic areas. Just what part they play in the course of the infections is undetermined.

Hemolytic streptococci were few or absent in all but 11 cases. The four patients in whom they predominated in the sputum, and the three who gave streptococci in pure culture died. Empyema was present in three of the fatal cases. The specimens of sputum which gave pure cultures of hemolytic streptococci were obtained within 48 hours before death.

The late appearance of hemolytic streptococci in the sputum and in the blood cultures, with the relatively infrequent occurrence in the series indicates that, however important they may be in determining the course of the disease, they were not the primary invaders.

The organisms most frequently found were the influenza bacillus and pneumococcus. They were found together in 47 cases. The influenza bacillus was supplanted by the pneumococcus in two cases and appeared before the pneumococcus in another case. In no instance did the influenza bacillus appear after the pneumococcus.

The influenza bacillus was found in 79% of the cases during the 1st month of the epidemic, and the highest number of cases giving a pure culture of influenza bacilli was found during the same month, while the number of cases showing pure cultures of pneumococci increased from 2 in October to 12 in January.

TABLE 2

Relations of Results of Bacteriologic Examination to Influenza and Pneumonia in Chicago

	October	November	December	January
Number of cases of influenza and pneumonia reported in Chicago	43,375	5,991	17,691	6,232
Percentage of cases studied in St. Luke's Hospital in which B. influenzae was found.................	78.9	54.5	43.3	36.3
Number of cases in which B. Influenzae was found in pure culture	7	0	4	2
Percentage of cases studied in St. Luke's Hospital in which pneumococcus was found.................	19	9	28.3	54.4
Number of cases in which pneumococcus was found in pure culture	2	1	8	12
Number of cases in which hemolytic streptococci were found in pure culture	0	0	3	0

Table 2 shows the relation of the epidemic in Chicago to the occurrence of pure cultures of pneumococci, influenza bacilli, and the hemolytic streptococci. The incidence of the influenza bacillus follows that of the epidemic most closely. The highest point for each is in October. The pneumococcus shows a rise during the recrudescence of the epidemic in December, and continues to rise in January, though the epidemic curve fell in that month. The figures include cases studied till the end of January (cases observed later than January 15, are not included in the 150 cases of table 1). The figures for the epidemic are the number of cases of influenza and pneumonia reported to the Chicago Health Department.

Table 2 also shows the relation of the percentage of cases in which influenza bacilli and pneumococci were found in either pure or mixed culture to the incidence of the epidemic. It is significant that the figures showing the incidence of the influenza bacillus were highest in October and fell steadily while the pneumococcus figures ran relatively low in October and rose as the frequency of the influenza bacillus fell. In general, the incidence of the influenza bacillus corresponds to that of the epidemic.

The disease clinically recognized as influenza was characterized by a leukopenia in the uncomplicated cases in contrast to the leukocytosis of lobar pneumonia. The average leukocyte count of both complicated and uncomplicated cases during the month of October when the epidemic was at its height was 6,400. The average leukocyte count when the influenza bacillus occurred in pure culture was 5,400. The average leukocyte count when pneumococcus was found in pure culture was 15,200.

As noted, types I, II, III and IV of pneumococci were identified. During October the influenza bacillus was found in 45 cases, and pneumococci in 11; eight of the pneumococcus strains isolated early in the epidemic belonged to type III, and the pure cultures of pneumococcus obtained in the month of October in two cases were both of this type. Later there were more cases of the other pneumococcus types and rarely one of type III. In the routine blood cultures in pneumonia during the winter of 1917-1918, the influenza bacillus (leptothrix form) was encountered once in pure culture in the blood from a case of bronchopneumonia with pleurisy. In April, 1918, the influenza bacillus was grown in pure culture from the pleural exudate of a soldier who had had bronchopneumonia.

Cole and MacCallum[1] in the pneumonia epidemic at Fort Sam Houston, and MacCallum[2] at Camp Dodge, found the influenza bacillus frequently in the late winter and early spring of 1918. Dick[3] found it to be the predominant organism in the sputum of 6% of the cases of pneumonia studied in the base hospital at Camp Pike in February and March, 1918. Tunnicliff[4] reports influenza bacilli in 58% of the sputum cultures at Camp Meade in the early fall of 1918. Though Cole and MacCallum found the influenza bacillus frequently, the bacteriologic picture of the epidemics they studied was dominated by hemolytic streptococci The epidemic at Camp Pike described by Dick was characterized by the predominance of both hemolytic streptococci and a streptococcus which had no effect on blood. The epidemic studied by Tunnicliff differed from the others by the predominance of a green-producing streptococcus.

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[1] Jour. Am. Med. Assn., 1918, 70, p. 1146.
[2] Ibid., 1918, 71, p. 704.
[3] Ibid., 1918, 70, p. 1529.
[4] Ibid., 1918, 71, p. 1733.

Whatever the etiology of influenza may be, secondary infection plays a most important rôle. It seems that in any one group of persons closely associated, the secondary invaders may be quite constant, but different in various groups; so that the results of the bacteriologic studies of different groups are conflicting. It is even possible that an organism entering the epidemic as a secondary invader may acquire such an increase in virulence that it is able to continue epidemic infection after the original cause has disappeared.

SUMMARY

In this series of cases drawn chiefly from the civilian population and belonging to no one group of people, M. catarrhalis, staphylococci, hemolytic streptococci, various types of pneumococci, including type III,[5] and B. influenzae were all found; usually in mixed culture, but sometimes singly. Of these organisms the influenza bacillus was the one most constantly present in October, when the epidemic was at its height, and the only one found in blood cultures of patients who recovered.

The leukocyte count in the cases of pure influenza bacillus infection was low, corresponding to the leukopenia regarded as characteristic of epidemic influenza.

The influenza bacillus may be present in pure culture early in the disease and be supplanted by the pneumococcus later. In this series none of the patients with a pure influenza bacillus infection died.

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[5] This organism appeared as diplococci in direct smears of the sputum, and formed large, flat, moist colonies on blood-agar plates. The colonies tended to coalesce, resulting in ameboid shapes. The organism was soluble in bile, but dissolved more slowly than the other types. It fermented inulin, and was agglutinated by type 3 pneumococcus serum.